

When New Technology is an Answer for Old Problems: The Use of Videoconferencing in Cognitive Aging Assessment

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Abstract. People living with cognitive impairment and dementia require regular screening of their symptomatology and needs. Brief cognitive screening is crucial for assessing these conditions. Such screening can give health professionals a snapshot of the patient's cognitive abilities and help in their monitoring and adaptation. An appropriate administration of brief cognitive screening using telemedicine technology, such as videoconference, can improve access to care and treatment planning. Moreover, the burden that rural and underserved communities often suffer because of limited access to specialty mental health services is also of concern. Herein, in this review, we describe the existing and relevant research regarding the administration of neuropsychological instruments via videoconferencing, and suggest methodological improvements for further studies. To date, only a handful of scientific studies have been published documenting the feasibility and acceptability of videoconferencing among older people and health professionals. Varying in their assessment tools, the studies demonstrate the reliability of cognitive testing and clinical diagnosis of dementia via videoconferencing, as noted by the associations between results of several cognitive tests using it as compared to face-to-face interviews. Further research is required to replicate findings and bring new solutions for their adaptation to a wide range of individuals, health professionals, areas of practice and settings.

Keywords: Cognitive testing, dementia, neuropsychology, telemedicine

INTRODUCTION

Over the last two centuries, the human species worldwide has experienced an impressive progress in health and life expectancy. In fact, currently no country in the world has a lower life expectancy compared to those with the highest life expectancy in 1800, and since 1900 the global average life expectancy

has more than doubled. However, one of the societal and clinical challenges associated with an aged population is the increased incidence of cognitive impairment, imposing the need for convenient, valid and reliable methods to monitor cognitive functions in the older population. This is a must in order to aid the detection, prevention and/or early intervention, of cognitive decline and/or cognitive (impairment) disorders [1].

In older individuals, standardized neuropsychological evaluations are generally used to screen, characterize and quantify cognitive decline. It is the

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prime criterion of diagnosis, treatment and follow-up of patients with or at-risk for dementia [2]. However, despite of its potential significant benefits, neuropsychological testing has been significantly limited by its need for in-person/face-to-face (FTF) contact and by the costs with travel, overhead, visits and missed visits [2]. For instance, patients who live in rural communities, and/or in remote distances, from medical centers and geriatric services, have difficulties to be screened or evaluated for cognitive performance/status [3, 4]. Also, it has been described that since that transportation is frequently a problem for individuals with dementia, those that are dependent on caregivers may be deprived of this resource [5]. To overcome such limitation(s) there has been a call for increased use of information and communication technologies to render remote cognitive assessment more readily available [6, 7], including the use of instruments that allow users to have visual stimuli, rather than simply auditory stimuli (e.g. via telephone assessment), during communication [8, 9]. Using modern information and communication technology, telemedicine blends the needs of patients and technological progress. On this, telemedicine refers to the use of telecommunication technology to deliver health-related services from distance and is thought to be a potential solution in bringing those services to remote and/or underserved areas [10]. Its successful implementation depends on a number of factors, with appropriate use of technology being a necessary basis [11]. Regardless the purpose, there are two main methods in which telemedicine can be conducted: real-time and store-and-forward. In the latter, the information is captured and stored, and then transmitted to the recipient for subsequent reply, it doesn't involve live interaction [12]. Real-time telemedicine allows participants to send and receive information almost immediately. Videoconferencing (VC) is an example.

In this background, besides the use of the telephone, videoconferencing [13] is thought to potentially complement and/or offer potential advantages over FTF assessment [14]. This method of assessment has grown rapidly in recent times partly due to the increasing availability and affordability of computers with video capacity and of communication by internet. Videoconferencing has been the most common application of telemedicine care and has been used to carry out cognitive assessments, to conduct psychiatric interviews and consultations, and to help in management of conditions such as stroke, diabetes mellitus, chronic illness, cancer, depression

and post-traumatic stress [15]. Besides improving the assistance to (older) individuals who already have (mild) cognitive impairment, it can also reach those that still without deficit and/or professionally active, those living in rural settings and with insufficient healthcare resources, avoiding time and money loss due to travel and time missed at work. By using videoconferencing technology, health professionals and patients can reduce the costs with regular clinic visits. Besides that, videoconference also allows hospitals to create networks to provide each other with support and improve care. By easily sharing their knowledge, health professionals can provide faster and more efficient services through earlier diagnosis and better management of, for instance, chronic disease [10]. At last, videoconferencing may as well improve the capacity to reach a great number of individuals located at multiple stations in a short period of time, offering timely responses and aiding in epidemiological data collection. In this line, Dorsey and colleagues evaluated in a randomized clinical trial the feasibility, effectiveness and economic benefits of videoconference care for 20 individuals with Parkinson disease in their home [16]. They reported that videoconference offered similar clinical control, and saved participants 100 miles of traveling and 3 h of time.

Herein we describe the existing and relevant studies regarding the administration of neuropsychological tests via VC, and suggest methodological improvements for future research.

METHODS

The databases *Pubmed* and *Psychinfo* were searched for relevant journal articles published in English, using a combination of the search terms with reference to applicability of cognitive tests via VC: telemedicine, videoconferencing, aging (ageing), cognition, Alzheimer, dementia and neuropsychological assessment. Though there are different ways in which telemedicine applications are being used to provide neuropsychological services, this manuscript was limited only to the discussion of the use of videoconferencing. On this, studies should address a videoconference approach between a health professional and an older patient (aged above 50 years old) for the purpose of diagnosis and/or cognitive assessment, with relevant reporting of statistical results. Publications were limited for the period of 2000 to 2016. Titles and abstracts were evaluated as a first

step and then full-text articles were read for their relevance to this review. In addition, bibliographies from the obtained articles were screened for relevant publications. The search was conducted between May 2016 and January 2017, with a total final of 20 studies with the inclusion characteristics properly identified.

RESULTS

Accuracy of cognitive testing in cognitive impairment using videoconferencing

In cognitive impairment care, telemedicine has been used in the areas of patient diagnosis/assessment. The evaluation of cognitive functioning via VC using standardized assessment tools has been shown to correlate well with FTF testing (e.g., [2, 3, 17–20]). Some of cognitive instruments frequently used via VC include the Mini-Mental State Examination (MMSE), Standardized MMSE, Clock Drawing test, Short Blessed test, Rowland Universal Dementia Assessment Scale (RUDAS), Digit Span, Hopkins Verbal Learning test – Revised (HVLTR) and tests of verbal fluency. The accuracy of a range of cognitive tests that are commonly used in dementia evaluations was tested by Cullum et al. in 14 patients with mild cognitive impairment and 19 patients with mild to moderate Alzheimer’s disease [2]. The study demonstrated the comparability of VC-based and traditional in-person testing conditions, indicating robust correlations between the two modalities [e.g., MMSE ($r=0.89$), Boston Naming test ($r=0.88$), digit span ($r=0.81$), category fluency ($r=0.58$), and letter fluency ($r=0.83$)], providing a good indicator that cognitive assessment via VC may to be a valid and reliable means to conduct neuropsychological evaluations in older individuals with cognitive impairment. A few years later, Cullum and colleagues [21] increased the sample size of their investigation to 202 individuals (83 with cognitive impairment and 119 healthy controls) from both rural and urban settings. Using the approach previously described, they found highly similar results across the VC-based remote and in-person assessment conditions, with significant associations between test scores. Although they had used a larger sample, the authors suggest that the battery of tests applied should have been comprehensive in order to verify which neuropsychological tests can be administered validly by VC, and those that are not so suitable. In a study that focused on the effectiveness of language evaluation in

mild Alzheimer’s disease patients, Vestal et al. compared VC with in-person language assessments [5]. Findings from the Wilcoxon signed rank test revealed no significant differences in performance on each of the 5 language tests between VC and in-person modalities, and, altogether, VC proved to be promising for speech and language evaluation services in dementia [5].

Other studies have focused on specific cognitive tests, such as the Mini-Mental State Examination (MMSE; [17, 22, 23]). Applying the MMSE via telemedicine, Loh et al. aimed to determine the inter-rater reliability of this instrument through VC, as compared to FTF administration, in 20 geriatric patients with diversified diagnoses (normal, dementia and depression) [18, 23]. Data indicated that assessments performed by distance with the MMSE using VC yielded similar results to direct evaluations. Timpano et al., whose study validated an Italian version of the 28-item VC-based MMSE (VMMSE) in cognitively impaired and healthy subjects, also concluded that VC is a valid method for clinical and research screening [24]. The results demonstrated that VMMSE has high levels of sensitivity and specificity for the optimal cutoff identification and an accuracy of 0.96. Moreover, VC was preferred over FTF, as it allowed real time communication between the health professional and the patient. Ciemins and colleagues examined the reliability of MMSE administration via remote way in a sample of 72 patients with diabetes [22]. The main focus was to assess the auditory and visual components of the administration. Findings revealed that 80% of individual items demonstrated remote to FTF agreement of $\geq 95\%$ and all item were $\geq 85.5\%$. However, due to the study design only the differences between the scores of the two methods were documented.

In more recent studies, other tests have also been evaluated for their feasibility and reliability when comparing VC with FTF test conditions. Galusha-Glasscock and colleagues [25] found that the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) could be administered via VC, with similar scores obtained when the RBANS was administered in-person. Using three different assessment approaches (VC, telephone and in-person), Castanho et al. [20] sought to determine if the use of VC with the Telephone Interview for Cognitive Status Modified – Portuguese (TICSM-PT; [26]) provided comparable information to an in-clinic evaluation. Findings indicated that the VC-based testing yielded similar results to the traditional

FTF administration and that cognitive test assessment via VC is a tool for consideration by the health professionals to reliably follow-up their patients who live in different settings.

Dementia diagnostic services in clinical settings using videoconferencing

Barton et al. described a VC neuropsychological assessment in a clinical setting [19]. Using VC, a comprehensive battery of tests comprising clinical and neurologic assessments was performed to 15 veterans. Results indicated that VC is a feasible method to provide consultation and care to people who would otherwise not have access to it. It was also possible to reach a working diagnosis and recommend relevant treatments for each patient. Additionally, with a clinical sample, Harrell and colleagues demonstrated that the majority of patients evaluated by them via telemedicine had an inaccurate diagnosis at the time of the FTF consultation [15]. With the administration of a neuropsychological battery of tests via VC, the investigators identified missed and unrecognized mental health treatments needs in over 77% of the patients referred. Telemedicine, thus, proved to be a valuable resource to clarify cognitive and psychiatric diagnoses. Moreover, a study by Martin-Khan and colleagues designed to validate the diagnosis of dementia via VC using a sample of 205 patients demonstrated a significant agreement for the primary outcome “Does the patient have dementia?” between VC and in-person testing conditions [27].

Users’ and cultural acceptability of videoconferencing

Research on VC-based neuropsychological assessment has been promising in terms of subject satisfaction and acceptability. Parikh et al. indicate that when asked about their preference, 98% of the individuals evaluated in the traditional FTF condition and via VC expressed high satisfaction with both test modalities, and 60% indicated no preference for a test condition [28]. After completing a questionnaire that evaluated the usefulness of the VC interaction, its efficacy compared to FTF or telephone testing modalities and willingness to try VC again, the same high satisfaction level was seen in the study of Shores et al. with a group of veterans [3]. In addition to the good acceptability, there was 100% agreement in dementia diagnoses between in-person and VC assessments. In another study, Grosch and colleagues

documented that the individuals did not experience any difficulties in adapting to the testing environment or procedures, and they expressed satisfaction with the VC assessment [29]. In turn, with a sample of healthy volunteers, the study of Hildebrand and colleagues revealed a preference for in-person testing (44%), but because 39% of the individuals indicated no preference the authors to conclude good acceptance of VC-based assessments [14].

Telemedicine diagnosis and assessment have also been welcomed in Spanish-speaking and Native American populations from remote and rural settings where access to specialized care is restricted [13, 30, 31]. Using a Spanish-language battery of cognitive tests via VC, Vahia and colleagues compared it to in-person and found no significant differences between cognitive scores [30]. Additionally, the study of Weiner et al., in a sample of individuals with dementia of the Choctaw Nation, suggested that the use of VC to diagnose and treat cognitive disorders was a feasible alternative to the traditional FTF examination [13]. High levels of acceptability of VC use were found amongst this specific sample, with only 3% not showing for VC meetings and 2 individuals refusing to be examined afterwards [13]. Wadsworth and colleagues [31] also adds to the growing literature on the feasibility and reliability for remote neuropsychological assessment by demonstrating that test scores were highly similar between VC and face-to-face conditions in their sample of American Indians.

DISCUSSION

The state of the art described here provides evidence that VC is feasible and acceptable among many older people and health professionals. Studies have demonstrated the reliability of cognitive testing via video-telemedicine, as noted by the correlations between results of various cognitive tests using VC as compared to in-person interview. Specifically, MMSE via telemedicine (e.g., [18, 22, 23]) can be as accurate as FTF, as well as particularly useful in documenting cognitive stability or decline. Other studies have compared the results of several neuropsychological tests, through FTF and VC, in patients cognitively intact and with dementia. These studies did not find any significant difference between the two testing modalities and showed that patient acceptance and satisfaction with telemedicine is high. Moreover, comparisons of diagnosis made FTF and via

VC suggested that clinical diagnosis of dementia via telemedicine consultation is valid and reliable [3, 23].

Although VC increases access to particular services, there are inherent challenges specific to its use. Concerning the administration of neuropsychological tests, the ones that are the standard of care for assessment of older adults include measures that are sometimes not feasible for VC administration [15]. One should be careful in that videoconferencing interaction must be as similar as possible to the traditional in-person administrations as much as possible. If test instructions are modified significantly for VC administration, standardized scoring protocols, and perhaps different norms, may be needed [10]. Health professionals have an ethical responsibility to maintain psychometric standards and test integrity. Also, participants tested by the same health professional in both conditions (VC and FTF) may inflate test-retest correlations. Furthermore, using and learning new technology often demands keen perceptual and cognitive abilities which tend to decline as we get older. Therefore, the use of VC can be limiting for patients with significant sensory and auditory problems or those with more severe confusion or communication difficulties [32]. Finally, it should be kept in mind that results cannot yet be extrapolated or generalized because, to date, most studies have been conducted in small and non-randomized samples, and in specific settings.

Related to the technology itself, ensuring that data and equipment are secure is crucial. This includes the use of a VC system with appropriate levels of data encryption to anonymize the messages between the patient and health professional, electronic signatures and privacy safeguards, so to prevent data loss and maintain confidentiality. However, since that health professionals have a limited control when patient information is transmitted wirelessly, these potential risks should be explicit in the informed consent [10, 33]. Technical problems concerning technology can also compromise the effectiveness of assessments via VC. If there is poor quality of transmission, relevant testing information may be lost and a clear view of patients' behavior may be disrupted. If there are lapses in sound, camera resolution or internet band width, the person that is administering the test has to repeat the instructions and, thus, the validity of some results, their scoring and interpretation may be compromised [10]. However, it must be pointed out that recent technological advancements have been phenomenal in mitigating many of the shortcomings found in older studies.

Early studies suggest that VC technology is a particularly useful medium to help extend neuropsychological assessments specifically to rural elderly communities [3, 14]. However, they may face some issues with the necessary broadband infrastructure of telemedicine. In fact, remote assessments amount to nothing if there isn't the network infrastructure to support it. Related to this, another challenge that can be found is to ensure that health professionals have the necessary information/education and technical competence to manage and adapt to any new health services they want to deliver [33].

Taking into account VC limitations, some recommendations are necessary for its use. First, before incorporating an instrument into a VC assessment, its reliability in the administration needs to be confirmed in the population setting attending to factors such as education level, cultural aspects and exposure to technology. Those who administer neuropsychological testing should also guarantee competence in the practice of cognitive assessment via telemedicine, including appropriate educational background, and proper training [22]. It should also be carried out an evaluation of the possible effects of sensory impairment and presence of psychiatric disorders on performance and subject's reactions to VC, previous to the assessment itself. A critical factor in acceptance of technology is its ease of use. Telemedicine through video should be simple and appropriate for the individual's competence. This is especially pertinent for people with dementia who usually have reduced processing speed, less manual dexterity and low visual acuity.

Remote assessments may inhibit key components of communication that are important for the patient-health professional relationship. For instance, due to the need to look into a camera when videoconferencing, the individual often makes contact with the other's image on the screen and not to the camera. This phenomenon may hinder the establishment and maintenance of eye contact, an aspect that has been associated with rapport and empathy bond. In order to ensure care and due considerations, it is suggested an initial interaction via VC for several minutes to help in developing rapport and familiarize the patient with the VC environment and equipment [10]. An important concern is also what to do if a patient becomes anxious or has a medical emergency during a remote assessment session. Having a security plan can be a solution. This should include procedures such as emergency contacts from where the patient resides [34]. Engaging someone who can intervene locally

in technical problems, such as a family member or a close friend, is crucial.

Additionally to the need of high-quality videoconferencing equipment to protect against breaches of privacy and confidentiality, health professionals should ensure no other subjects enter the room at any time during the assessment without patient's consent [10]. Although there are few guidelines to orient health professionals as to ethical and utilization of telemedicine, the American Telemedicine Association and the American Psychological Association (APA) made available specific guidelines to highlight best practices and type of recommended conduct when providing psychological services using technology [34, 35]. In 2013, the APA Task Force developed their recommendations based on identified data and experiences and then, they examined the research produced on the effectiveness, ethical concerns, legal questions, and practical concerns. These guidelines are necessary in research and clinical settings in order to ensure the protection of both patient and health professional, and that assessments and other services via VC interactions are similar to the traditional face-to-face approach [10]. At last, future studies should consider the use of larger and mixed diagnostic samples, as well as focus on subjective assessment of satisfaction/acceptability of telemedicine and not only administering cognitive tests. Further research is, thus, still warranted to fully establish the feasibility of conducting remote cognitive assessments and dementia diagnosis in real-life than experimental settings.

Conclusions

Telemedicine represents an excellent approach in the incorporation of technology, such as videoconferencing, in bridging the distance between health professionals and patients. On this, VC can be a useful tool in the screening and signaling patients with specific needs for further examination or follow-up. Moreover, the use of 'telemedicine' in cognitive assessment has the potential to support people with dementia while improving patients' quality of life and reduce healthcare costs [36]. The current state-of-the-art indicates for its use being as effective as an in-person evaluation, and an acceptable approach to assess those in underserved and remote areas. Still, despite the promising results, further research is required to replicate findings and bring a new solution to an old problem: to reach all individuals.

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CONFLICT OF INTEREST STATEMENT

The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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